

## **Supplemental material for Question 1:**

### **What is a healthy Puget Sound?**

**Assessing progress toward restored environmental health of  
Puget Sound: outcomes, indicators, targets and benchmarks**

## **Assessing progress toward restored environmental health of Puget Sound: outcomes, indicators, targets and benchmarks**

Washington State statute defines six goals and eight objectives to be achieved by the Puget Sound Partnership's efforts to restore the environmental health of Puget Sound by 2020 (RCW 90.71.300). This statute specifies that Partnership's action agenda shall include "measurable outcomes for each goal and objective specifically describing what will be achieved, how it will be quantified, and how progress toward outcomes will be measured." (RCW 90.71.310)

The Partnership will use the outcomes, indicators, targets and benchmarks introduced in this document to evaluate progress towards restored environmental health. These outcomes, indicators, targets and benchmarks are a critical component of the Partnership's performance management approach (discussed in section 3, Part E of the Action Agenda), which will also include performance measures for tracking implementation and evaluating the effectiveness of strategies, tactics, and actions.

### **1 Goals, outcomes and indicators**

The tables below present the outcomes and indicators adopted by the Partnership to describe success in achieving each of six ecosystem recovery goals (defined in RCW 90.71.300). The presentation of outcomes by goal below suggests a one-to-one relationship among goals and outcomes, which the Partnership recognizes as an oversimplification of the actual, many-to-many relationships. Exhibit 1 illustrates some of the complexity of these relationships and demonstrates that most desired outcomes provide information about more than one ecosystem recovery goal.

Exhibit 2 illustrates how the outcome measures relate to the eight ecosystem recovery objectives. Seven of the objectives defined in statute are addressed by the outcomes adopted by the Partnership. The objective to "build and sustain the capacity for action" is not specifically addressed by these outcomes but is addressed in the action agenda's overall strategic approach and the strategic priorities and actions discussed in Sections 3 and 4.

Although outcomes are more finely resolved than the six ecosystem recovery goals, each outcome still encompasses a breadth of issues. Consequently, the Partnership has identified multiple indicators for most outcomes.

The indicators presented in this section have been adopted by the Partnership as provisional for the 2008 Action Agenda. Continuing scientific evaluation of the Puget Sound ecosystem will improve understanding of how the ecosystem is structured and how it works. The Partnership will use advances in understanding the ecosystem to provide a scientific basis for its efforts to refine indicators and benchmarks as an early focus of the Partnership's adaptive management.

The provisional indicators adopted by the Partnership and presented below were identified through a technical evaluation of available ecosystem indicators led by staff from NOAA's Northwest Fisheries Science Center (draft summary report provided to Partnership's Science Panel on August 5, 2008; human well-being indicators recommended in October 2, 2008 memo from Mark Plummer). For five of six goals, all indicators determined by the technical evaluation to be relevant and appropriate for Partnership purposes are included in the sections below consistent with advice from the Partnership's Science Panel. For indicators of human well being, the evaluation team further screened the relevant and appropriate indicators to develop a recommended subset of indicators for use by the Partnership. The section below on human well-being presents only the recommended subset of relevant indicators.

Some of the indicators presented below are currently available (labeled "A" in the first column in the sections below) and others are potentially available (labeled "P"), meaning that additional work will be needed to for development of up-to-date, Sound-wide reporting on status and/or trends.

### ***Indicator Tables***

#### **1. A healthy human population supported by a healthy Puget Sound that is not threatened by changes in the ecosystem**

**Desired outcome: fish and shellfish are safe for people to eat**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Marine fish consumption advisory	Less restrictive dietary advice (compared to DOH human health evaluation) as concentrations decline
A	Acres and trends in shellfish commercial growing area closures	<b>Net increase of 1,000 acres per biennium based on improved sanitary conditions; net increase of 10,000 acres by 2020 based on improved sanitary conditions</b>
A	Shellfish closures and biotoxin levels for paralytic shellfish poison (PSP)	No illnesses or deaths from exposure to PSP
A	Shellfish closures and biotoxin levels for domoic acid	No illness or deaths from exposure to domoic acid
P	Shellfish consumption advisory	Baseline evaluation and advice, then less restrictive advice as concentrations decline
P	Freshwater fish consumption advisory	Baseline evaluation and advice, then less restrictive advice as concentrations decline

**Desired outcome: air is healthy for people to breathe**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Washington Air Quality Advisory (WAQA) index	Increased number of good air quality days measured by WAQA index per monitor
A	Air quality – particulates	No days with 24-hour concentrations of fine particulates (PM <sub>2.5</sub> ) above 20 ug/cubic meter

**Desired outcome: freshwaters are clean for drinking**

	Provisional indicator	Example of what success means
A	Drinking water quality in public water systems	1. Decrease in percent of public water supply sources with elevated nitrate 2. Decrease in percent of public water supply sources with significant increases in nitrate levels
P	Groundwater quality for drinking water	Reduced levels of arsenic and nitrate in ground waters used as drinking supplies

**Desired outcome: marine and freshwaters are clean for contact**

	Provisional indicator	Example of what success means
P	Percent of swimming beaches that meet safe swimming standards at all times during the summer	Increase in percent of swimming beaches that meet standards at all times in the summer
P	Fecal bacteria at lake swimming beaches	Decrease in fecal coliform bacteria levels at swimming beaches in King County small and large lakes

**2. A quality of human life that is sustained by a functioning Puget Sound ecosystem****Desired outcome: aesthetic values, opportunities for recreation, and access for the enjoyment of Puget Sound are continued and preserved**

	Provisional indicator	Example of what success means
A	Puget Sound recreational shellfish harvests	Sustained levels of annual harvest by species from individual beaches; sustained aggregate annual harvest from Puget Sound beaches
A	Puget Sound recreational finfish harvests	Increased levels of annual harvest by species for individual catch areas; increased aggregate annual harvest for Puget Sound
P	Puget Sound non-harvest recreational activity	Increased participation and frequency of activity for various recreational activities relative to 2006 baseline
P	Puget Sound publicly accessible or owned shoreline	Increased number of miles of Puget Sound shoreline that is publicly owned or publicly accessible relative to 2009 baseline

**Desired outcome: upland and marine resources are adequate to sustain the treaty rights, as well as the cultural, spiritual, subsistence, ceremonial, medicinal needs, and economic endeavors of the tribal communities of Puget Sound**

	Provisional indicator	Example of what success means
A	Puget Sound commercial Indian finfish and shellfish harvest	Increased levels of annual harvest by species for individual catch areas; increased annual aggregate harvest for Puget Sound

**Desired outcome: the Puget Sound ecosystem supports thriving natural resource and marine industry uses such as agriculture, aquaculture, fisheries, forestry, and tourism.**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Puget Sound commercial finfish and shellfish harvest, wild and aquaculture	Increased levels of annual wild and aquaculture harvest by species for individual catch areas; increased annual aggregate wild and aquaculture harvest for Puget Sound
A	Scenic and sightseeing water transportation	Sustained number of scenic and sightseeing water transportation establishments in each county
A	Marinas	Sustained number of marinas in each county
P	Puget Sound timber harvest	Sustained volume of timber harvest for each county and each ownership category
P	Puget Sound land in farms	Sustained acreage of land in farms in each county relative to 2007 baseline

**Desired outcome: the Puget Sound's economic prosperity is supported by and compatible with the protection and restoration of the ecosystem – no provisional indicators**

**Explanatory variables related to human well being**

	<b>Provisional indicator</b>
A	Total population
P	Developable land

### **3. Healthy and sustaining populations of native species in Puget Sound, including a robust food web**

**Desired outcome: viable marine, nearshore, freshwater, and terrestrial biological communities exist into the future and biodiversity is maintained**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Species Listed under Federal Endangered Species Act (ESA)	1. Maintain existing populations of federally listed species in a stable condition 2. Net decrease in number of species listed
A	Species of Concern on State list	Net decrease in numbers of species listed
A	Species on Conservation Concern	Net decrease in numbers of species listed
A	Marine benthic infaunal community structure	All Puget Sound benthic infaunal communities have abundance and diversity measures appropriate for the type of sediment they inhabit and are not dominated by stress-tolerant species
A	Terrestrial breeding bird count	Stable or increasing population trends by 2020 for all bird species of greatest conservation concern or identified as indicators by Partners in Flight
A	Marine bird mortality	
A	Fish and invertebrates at marine reserves	
A	Marine species at risk	Net decrease in numbers of species listed
A	Backyard wildlife populations	

Additional potentially available indicators include: groundfish status and trends, harbor seal food web interactions, marine fish/invertebrates at rocky habitats, benthic index of biotic integrity (BIBI) for rivers and streams

**Desired outcome: populations of marine, nearshore, freshwater, and marine species are viable into the future and biodiversity is maintained**

	Provisional indicator	Example of what success means
A	Bald eagle status and trends	
A	Pinto abalone status and trends	
A	Groundfish	
A	Herring	
A	Marine birds – breeding and non-breeding	Stable or increasing breeding and over-wintering marine bird species population trends by 2020
A	Southern resident orca whale population trends	
A	Salmon and steelhead status and trends	<b>Two to four viable populations of Chinook in each of five regions</b>
A	Taylor’s checkerspot butterfly status and trends	No loss of extant breeding populations and all populations categorized as stable or healthy by 2020
A	Peregrine falcon nesting surveys	
A	Pacific hake & other midwater fish status and trends	
A	Marine/shore birds – food web interactions	
A	Black oystercatcher abundance at nesting colonies	
A	Harbor seal status and trends	
A	Gray whale	
A	Harbor porpoise/Dall’s porpoise	
A	Waterfowl breeding surveys	
A	Band-tailed pigeon mineral site counts	
A	Mountain goat – status and trends	
A	Deer population – status and trends	

Additional potentially available indicators include: Christmas bird counts, species of greatest conservation need, Dungeness crab abundance, total number or spawning adult salmonids (hatchery and wild origin), total run size of salmonids (hatchery and wild origin), recruits per spawner for wild origin salmonids, salmonid diversity, salmonid population growth rate, smolt to adult return (SAR) for wild salmonids populations, egg to smolt survival (wild origin salmonids), waterfowl – status and trend of midwinter populations, stillwater breeding amphibians, marbled murrelet presence at occupied sites, elk – status and trends

**Desired outcome: non-native species do not significantly reduce native species viability or impair food web function**

	Provisional indicator	Example of what success means
P	Non-native invasive species threat in all habitats	Decrease in number of rare native species that are impacted or threatened by invasive, non-native species
P	Non-native nearshore species	

**Desired outcome: biological harvests are balanced, viable and ecosystem-based**

	Provisional indicator	Example of what success means
A	Dungeness crab harvest	
A	Marine associated waterfowl harvest	
A	Game species harvest	
P	Marine bottomfish harvest	
P	Harvest of wild salmonids populations	
P	Exploitation rates of wild salmonids populations	

**4. A healthy Puget Sound where freshwater, estuary, near shore, marine, and upland habitats are protected, restored, and sustained**

**Desired outcome: marine/nearshore habitats sustain diverse species and food webs and are formed by natural processes and human stewardship so that ecosystem functions are sustained**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Eelgrass	<b>1) Number of sites in Puget Sound with eelgrass gains exceed those with losses, in each action area and across entire region</b> <b>2) Increase in eelgrass distribution to maximum areal extent and depth evident in historical maps and other sources of information</b>
A	Marine parameters	1. Increase in Puget Sound water clarity by 2020 2. Increase in oxygen concentrations by 2020
P	Marine shoreline geomorphology	Conservation of important ecosystem features and successful restoration of "lost" ecosystem features
P	Kelp and other seaweeds	Extent of canopy-forming kelp beds sustained at baseline conditions
P	Saltmarshes	Increased acreage of saltmarsh habitat in each action area and across entire region
P	Intertidal biotic community status and trends	Intertidal biotic communities sustained at baseline conditions for each major shoreline habitat type
P	Shoreline armoring of marine/nearshore habitats	Net decrease in extent of armored marine shoreline in each action area and across the entire region

**Desired outcome: freshwater habitats sustain diverse species and food webs and are formed by natural processes and human stewardship so that ecosystem functions are sustained**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Physical habitat and freshwater parameters	Increase in number of stream miles/segments that meet water quality criteria for temperature, dissolved oxygen, pH, turbidity, fecal coliform, total suspended sediment, total phosphorus, and total nitrogen
P	Maximum temperature in freshwater	Decrease in maximum temperature (7-day moving average between June and September) at all sampling locations in each water resource inventory area
P	Channel armoring in freshwater habitats	Decrease in percent of channel length armored in each water resource inventory area
P	Floodplain connectivity in freshwater habitats	Improved connectivity measures in each water resource inventory area
P	Change in wetland acreage	Sustained acreage of riverine, palustrine and lacustrine wetlands in each action area and across the entire region
P	Number of artificial fish barriers	Decrease in number of barriers caused by culverts, weirs, and man-made gradient changes in each water resource inventory area
P	Fish passage barrier improvements	

**Desired outcome: terrestrial habitats sustain diverse species and food webs, sustain marine and nearshore habitats, and are formed by natural processes and human stewardship so that ecosystem functions are sustained**

	Provisional indicator	Example of what success means
A	Old growth forest change	Achieving Puget Sound relevant objectives in Spotted Owl recovery plan and Northwest Forest Plan
A	Transportation pressure	(1) No increase in number of road miles (by type) and road crossings within one mile of historically anadromous salmonid streams, floodplains, and marine shorelines (2) No decrease in miles where animals have potential to successfully cross transportation infrastructure
A	Road densities	Decrease in density of gravel and dirt roads in forest lands in each water resource inventory area
A	Land cover status and trends	<b>Minimal decrease in acreage of lowland forest and minimal increase in impervious area</b>

**Desired outcome: non-native species do not significantly impair habitat quality, quantity, or the processes that form and maintain habitats**

	Provisional indicator	Example of what success means
P	Non-native invasive aquatic marine species	Decrease in occurrence and areal coverage of Spartina, invasive tunicates, and other aquatic nuisance species

## 5. An ecosystem that is supported by ground water levels as well as river and stream flow levels sufficient to sustain people, fish, and wildlife, and the natural functions of the environment

**Desired outcome: freshwater quantity is sufficient to support freshwater and terrestrial food webs and human uses and enjoyment**

	Provisional indicator	Example of what success means
A	Snow pack	
A	Glacier mass balance	Sustained volume of glaciers
P	Annual maximum daily flow	No increase in maximum daily flow for 10 study streams
P	Annual mean flow	No decrease in annual mean flow for 10 study streams
P	Flow flashiness – TQmean	No increase in flow flashiness for 10 study streams
P	Annual 7-day low flow	No decrease in 7-day low flow for 10 study streams
P	Violations in Ecology instream flows	<b>Increase in percent compliance in wet years with established in-stream flows in each water resource inventory area</b>

**Desired outcome: freshwater delivery to shorelines and estuaries supports estuarine, nearshore and marine food webs and the habitats upon which they depend**

	Provisional indicator	Example of what success means
P	Stream flows to Puget Sound marine/nearshore habitat	No decrease in average daily freshwater inflow to Puget Sound from nine major rivers

**Desired outcome: flooding hazards do not harm people, residences, and transportation**

	Provisional indicator	Example of what success means
A	Frequency of flood events	No increase in frequency of flood events



**6. Fresh and marine waters and sediments of a sufficient quality so that the waters in the region are safe for drinking, swimming, shellfish harvest and consumption, and other human uses and enjoyment, and are not harmful to the native marine mammals, fish, birds, and shellfish of the region**

**Desired outcome: loadings of toxics, nutrients, and pathogens do not exceed levels consistent with healthy ecosystem functions**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Oil spills	1. Increasing trend in interval between major spills (>10,000 gallons) continues through 2020 2. Vessel incident rate remains below 1.2 percent
P	Toxics in biosolids from wastewater treatment plants	Decrease in mercury (and other contaminant) concentrations in biosolids
P	Nutrient and pathogen loadings in rivers to Puget Sound	No increasing trend in calculated watershed loads of nitrate, ammonia, organic nitrogen, orthophosphate, organic phosphorus, total phosphorus, and fecal coliform bacteria
P	Microbial pollution assessment – Sinclair-Dyes inlets	Decrease in loadings of fecal coliform bacteria to Sinclair-Dyes inlets relative to 2001-2005 baseline

**Desired outcome: toxics in marine waters and sediments, and in mammals, fish, birds, shellfish, and plants in these waters, do not harm the persistence of these species**

	<b>Provisional indicator</b>	<b>Example of what success means</b>
A	Chemical contamination in Puget Sound sediments	All Puget Sound sediments meet Sediment Quality Standards by 2020
A	Toxics in marine benthic fish	
A	Toxics in marine pelagic fish	<b>Decrease in PBDE concentrations in herring from south and central Puget Sound to levels observed in Strait of Georgia</b>
A	Liver disease in English sole	Decrease in risk of liver disease for English sole at eight stations
P	Sediment quality triad index	All Puget Sound sediments characterized by sediment quality triad index as <i>high</i> quality by 2020

Additional potentially available indicators include: acute toxicity associated with Puget Sound sediments, toxics in clams, toxics in mussels, fish tissue contamination index, contaminants in whole fish, toxics in juvenile salmon, toxics in osprey eggs, and toxics in harbor seals.

**Desired outcome: pathogens, nutrients, and ocean influences do not harm the mammals, fish, birds, shellfish, and plants that depend on the marine waters of Puget Sound**

	Provisional indicator	Success means ...
A	Fecal pollution index for commercial shellfish beds	<ol style="list-style-type: none"> <li>1. No new shellfish growing areas have FPI values above 1 (beyond the ~30 areas identified in 2005)</li> <li>2. No decline by 2020 in conditions at the shellfish growing areas with FPI values above 1 in 2005</li> <li>3. 10 percent of the shellfish growing areas with FPI values above 1 in 2005 improve significantly by 2015; 20 percent improve significantly by 2020.</li> </ol>
A	Marine water quality (multiple parameters)	<ol style="list-style-type: none"> <li>1. Decrease in the spatial extent and persistence of low oxygen zones (oxygen concentrations below ocean - source water concentrations) should significantly decrease</li> <li>2. No decline in minimum oxygen concentrations</li> </ol>
A	Nutrients in marine waters	<ol style="list-style-type: none"> <li>1. Seasonal nutrient concentrations (ammonia) are statistically indistinguishable from ocean source waters</li> <li>2. Significant improvement in relative nutrient compositions (DIN/P, NO<sub>3</sub>/NH<sub>4</sub>) by 2020</li> </ol>
P	Sensitivity to eutrophication in marine/nearshore habitats	

**Desired outcome: pathogens, nutrients, toxic contamination, sedimentation, elevated temperatures, and other water quality concerns do not harm fish, invertebrates, and wildlife that depend on the fresh waters of Puget Sound**

	Provisional indicator	Example of what success means
A	Water quality parameters in streams aggregated by Water Quality Index (WQI)	WQI scores are 80 or higher in each water resource inventory area
P	Phosphorus levels in small and large lakes	Improvement in phosphorus trophic state index for small and large lakes in King County
P	Dissolved oxygen and temperature in lakes	Increase in dissolved oxygen and decrease in temperature in King County lakes
P	Fecal bacteria in streams	Decrease in fecal coliform bacteria levels in Longfellow, Piper's, Thornton, and Fauntleroy creeks
P	Fecal bacteria at lake non-swimming beaches	Decrease in fecal coliform bacteria levels at non-swimming beaches in King County small and large lakes
P	Toxics in freshwater	Decrease in metals and un-ionized ammonia levels in Longfellow, Piper's, Thornton, and Fauntleroy creeks
P	Toxics in freshwater fish	Decrease in concentrations of PAHs, PCBs, and mercury in edible tissues of freshwater fish

## 2 Targets and benchmarks for evaluating and communicating recovery of ecosystem health

The Partnership has adopted candidate benchmarks for a limited number of indicators for each goal. This approach to setting benchmarks strikes a balance between the evaluation approach laid out in statute (i.e., definitive benchmarks and targets by which to evaluate progress

towards desired outcomes) and the Partnership’s recognition that there is little scientific basis for the selection of specific benchmarks and targets and little promise that near-term scientific advances will improve this situation. For most of the indicators adopted by the Partnership, progress will be described as an improving condition (i.e., a measurable change in the desired direction). In the indicator tables below, benchmarks and less specific definitions of an improving condition are provided for each provisional indicator in the column labeled “example of what success means.”

To help evaluate and communicate the success of the recovery effort, the Partnership is defining targets and benchmarks for a subset of its indicators:

- Shellfish growing areas
- Land cover change
- Chinook salmon viability
- Eelgrass
- Instream flows
- Toxic chemicals in fish

The table below presents provisional targets and benchmarks for these indicators. These targets and benchmarks can be used to quantitatively assess progress toward some key dimensions of ecosystem recovery. Without targets and benchmarks, evaluations of progress might be too vague to help direct adaptations of future work.

This suite of six benchmarked indicators was designed to address each of the Partnership’s six ecosystem recovery goals and provide information relevant to a broad variety of desired ecosystem outcomes using a small number of indicators. A focus on this suite will not fully depict progress toward recovery; many ecosystem recovery outcomes are not directly addressed by this small set of indicators.

The Partnership has selected provisional targets and benchmarks that appear to be achievable (but challenging) and that describe a future that is improved relative to current or projected conditions. In most cases the provisional targets and benchmarks presented do not reflect a scientific determination of the conditions needed to ensure ecosystem viability. Such a science basis for targets and benchmarks would be preferred but is not available given current scientific understandings. The discussion below explains the rationale for including each indicator in this suite and the rationale for selection of the specific target and benchmark.

**Provisional targets and benchmarks for evaluating Puget Sound ecosystem recovery**

<b>Provisional Indicator</b>	<b><i>Target – desired condition for 2020 (unless other date specified)</i></b>	<b><i>Benchmark – interim milestone</i></b>
Shellfish growing areas	Net increase of 10,000 acres of commercial shellfish growing area open for direct harvest based on improved sanitary conditions	Net increase of 1,000 acres of commercial shellfish growing area open for direct harvest each biennium based on improved sanitary conditions
Land cover	For each action area: forest acreage below 1000 feet is at least 90% of 2001 level and impervious area is not more than 120% of 2001 level	For each action area in 2011: forest acreage below 1000 feet is at least 95% of 2001 level; impervious area is not more than 110% of 2001 level
Salmon and steelhead status and trends	By 2055, two to four viable populations of Chinook salmon in each of five regions: Strait of Georgia, Strait of Juan de Fuca, Hood Canal, Whidbey Basin, and Central/South Puget Sound. Remaining populations and watersheds are providing ecological functions consistent with population and ESU viability.	Recovery Council and NOAA Fisheries implementation review in 2015 finds that the status of populations is improving and the primary factors limiting the status of populations and the ESU are decreasing.
Eelgrass status and trends	Acreage of eelgrass in each Action Area recovers to estimated historic number of acres	Sites with increasing eelgrass area outnumber sites with decreasing area
Percent exceedance of instream flows	In wet years, instream flows in all watersheds exceed minimum low flow levels set by rule or other agreement	In wet years, instream flows exceed minimum low flow levels set by rule or other agreement
Toxics in pelagic fish	PBDE levels in Pacific herring from south and central Puget Sound are not higher than levels in herring from the Strait of Georgia	In 2014, PBDE levels in herring from Puget Sound and Georgia Basin are not higher than levels observed in 2004

**Rationale for targets and benchmarks**

Goals and outcomes addressed. The suite of indicators includes at least one measure relevant to each of the six ecosystem recovery goals:

- Human health – shellfish growing areas and toxics in pelagic fish

- Human well being – land cover, shellfish growing areas, and toxics in pelagic fish
- Species and food web viability – Chinook population viability, eelgrass, instream flows (a limiting factor for some populations of Chinook), toxics in pelagic fish (one of three concerns for recovery of southern resident orcas)
- Habitat – eelgrass, land cover, Chinook population viability, instream flows
- Water quantity – instream flows, land cover
- Water quality -- toxics in pelagic fish and shellfish growing areas, land cover

Where more than one indicator in the suite addresses a goal, we are representing multiple outcomes within the goal (e.g., measures of the safety of shellfish and fish for humans, measures of nearshore, terrestrial, and freshwater habitats). Given that we're trying to address a large number of goals and outcomes with relatively few indicators, this type of overlap is important.

Outcomes not addressed. A number of outcomes (and concepts within outcomes) are not addressed by this subset of indicators:

- Human health: drinking water, air quality, water quality to support contact recreation
- Human well-being: aesthetic values, non-harvest recreation, economic prosperity
- Species and food web: viable communities, viable populations of marine and terrestrial species, non-native species, harvests
- Habitats: non-native species
- Water quantity: freshwater quantity sufficient for human uses and enjoyment, freshwater delivery to shorelines and estuaries, flooding hazards; climate change impacts
- Water quality: loadings of pollutants, pathogens and nutrients do not harm marine components, pollutants do not harm fresh waters, nutrients and low dissolved oxygen issues in freshwater and marine areas.

Alternative suites of indicators. The suite of indicators with targets and benchmarks presented in this document is one of many possible combinations. Alternative suites of indicators could be developed by shifting to other potential targets and benchmarks, including:

- Days with 24-hour PM2.5 concentrations above goal of 20 ug/cubic meter
- Sustained number of scenic and sightseeing water transportation establishments
- Stable or increasing population trends for all bird species of greatest conservation concern
- Sustained acreage of wetlands
- Marine vessel incident rate remains below recent level of 1.2 percent
- Freshwater water quality index scores of 80 or higher in each watershed

Selection of targets and benchmarks. The specific target and benchmark levels presented in this document were determined as follows:

- Shellfish growing areas – recommended by Department of Health based on recent trends in reclassifications due to changes in sanitary conditions; 10,000 acres goal should include accomplishments in 2007-09.
- Land cover change – staff suggestion to acknowledge and accept some decline relative to current situation (as not all new growth will occur in already developed areas); remnant of 90% of 2001 low elevation forest and increment of 20% more impervious are based on an approximate continuation of 1991-2001 trends (Sound-wide 3.9% loss of low elevation forest and 10.4% increase in impervious area) but not related to knowledge of thresholds
- Chinook salmon viability – staff suggestion to focus on one portion of multi-faceted goals for salmon recovery

- Eelgrass – recommended by Department of Natural Resources staff
- Instream flows – staff suggestion to adopt 100 percent compliance in wet years with minimum low flows from instream flow rules or other agreement. Low flows are not met in dry years – those years are acknowledged not to be as productive for fish. Wet years would need to be defined; this definition could be adjusted with changes in climate
- Toxic chemicals in fish – staff suggestion to set goals for PBDEs (brominated flame retardant chemicals) for south and central Puget Sound concentrations that would not be higher than observed in the lesser contaminated northern waters of the basin. Although no trend information is available for PBDEs in herring, PBDEs appear to be increasing in the region: the benchmark suggests that this increasing trend is halted as an interim milestone toward the ultimate declining concentrations suggested for 2020.

EXHIBIT 1: Relationships among ecosystem recovery goals and desired outcomes

Ecosystem Outcome <i>describes success in achieving which ecosystem recovery goal</i> <sup>1</sup>	Human health	Human well-being	Species, food webs, biodiversity	Habitats	Water quantity	Water quality
Fish and shellfish are safe for people to eat	❶	❷				❷
Air is healthy for people to breathe	❶	❷				
Freshwaters are clean for drinking	❶	❷				❷
Marine and freshwaters are clean for contact	❶	❷				❷
Aesthetic values, opportunities for recreation & access for the enjoyment of PS are continued & preserved		❶				
Terrestrial and marine resources are adequate to sustain the treaty rights, as well as the cultural, spiritual, subsistence, ceremonial, medicinal needs, and economic endeavors of the tribal communities of PS	❷	❶			✧	
PS ecosystem supports thriving natural resource and marine industry uses such as agriculture, aquaculture, fisheries, forestry, and tourism		❶		✧	✧	
Economic prosperity is supported by and compatible with the protection and restoration of the ecosystem		❶		✧	✧	
Viable marine, nearshore, freshwater, and terrestrial biological communities exist into the future and biodiversity is maintained		✧	❶	✧		
Populations of marine, nearshore, freshwater, and marine species are viable into the future	✧	❷	❶	✧		
Non-native <sup>1</sup> species do not significantly reduce native species viability or impair food web function		✧	❶	✧		
Biological harvests are balanced, viable and ecosystem-based	❷	❷	❶	✧		
Marine/nearshore habitats sustain diverse species and food webs and are formed by natural processes and human stewardship so that ecosystem functions are sustained		✧	✧	❶	✧	✧
Freshwater habitats sustain diverse species and food webs and are formed by natural processes and human stewardship so that ecosystem functions are sustained		✧	✧	❶	✧	✧
Terrestrial habitats sustain diverse species and food webs, sustain aquatic habitats, and are formed by natural processes and human stewardship so that ecosystem functions are sustained		✧	✧	❶	❷	❷
Non-native species do not significantly impair habitat quality, quantity, or the processes that form and maintain habitats		✧	✧	❶	✧	
Freshwater quantity & flows support freshwater and terrestrial food webs and human uses and enjoyment	❷	❷	✧	✧	❶	✧
Freshwater delivery to shorelines and estuaries supports estuarine, nearshore and marine food webs and the habitats upon which they depend		✧	✧	✧	❶	✧
Flooding hazards do not harm people, residences, and transportation	❷	❷	✧	✧	❶	
Loadings of toxics, nutrients, and pathogens do not exceed levels consistent with healthy ecosystem functions		✧	✧	✧		❶
Toxics in marine waters and sediments, and in mammals, fish, birds, shellfish, and plants in these waters do not harm the persistence of these species	✧	✧	❷	❷		❶
Pathogens, nutrients, and ocean influences do not harm the mammals, fish, birds, shellfish, and plants that depend on the marine waters of PS	✧	✧	❷	❷		❶
Pathogens, nutrients, toxic contamination, sedimentation, elevated temperatures, and other water quality concerns do not harm fish, invertebrates, and wildlife that depend on the fresh waters of PS	✧	✧	❷	❷		❶

<sup>1</sup> ❶ = outcome is a primary means of defining success for this goal; ❷ = outcome is directly relevant to achieving this goal; ✧ = indirect relationship b/w outcome & goal

## EXHIBIT 2: Relationships among ecosystem recovery objectives and outcomes

Ecosystem outcome <i>describes success in achieving which ecosystem recovery objectives</i> <sup>2</sup>	Protect habitat	Restore habitat	Reduce toxics	Reduce nutrients & pathogens	Storm-water	Water quantity	Biodiversity & imperiled species	Capacity for action
Fish and shellfish are safe for people to eat			②	②	❶			
Air is healthy for people to breathe								
Freshwaters are clean for drinking			②	②	②			
Marine and freshwaters are clean for contact			②	②	❶			
Aesthetic values, opportunities for recreation & access for the enjoyment of PS are continued & preserved								
Terrestrial and marine resources are adequate to sustain the treaty rights, as well as the cultural, spiritual, subsistence, ceremonial, medicinal needs, and economic endeavors of the tribal communities of PS						✧		
PS ecosystem supports thriving natural resource and marine industry uses such as agriculture, aquaculture, fisheries, forestry, and tourism	✧	✧				✧		
Economic prosperity is supported by and compatible with the protection and restoration of the ecosystem	✧	✧				✧		
Viable marine, nearshore, freshwater, and terrestrial biological communities exist into the future and biodiversity is maintained	✧	✧			❶		❶	
Populations of marine, nearshore, freshwater, and marine species are viable into the future	✧	✧			②		❶	
Non-native <sup>1</sup> species do not significantly reduce native species viability or impair food web function	✧	✧					❶	
Biological harvests are balanced, viable and ecosystem-based	✧	✧					❶	
Marine/nearshore habitats sustain diverse species and food webs and are formed by natural processes and human stewardship so that ecosystem functions are sustained	❶	❶	✧	✧	✧	✧	✧	
Freshwater habitats sustain diverse species and food webs and are formed by natural processes and human stewardship so that ecosystem functions are sustained	❶	❶	✧	✧	✧	✧	✧	
Terrestrial habitats sustain diverse species and food webs, sustain aquatic habitats, and are formed by natural processes and human stewardship so that ecosystem functions are sustained	❶	❶	②	②	②	②	✧	
Non-native species do not significantly impair habitat quality, quantity, or the processes that form and maintain habitats	❶	❶				✧	✧	
Freshwater quantity & flows support freshwater and terrestrial food webs and human uses and enjoyment	✧	✧	✧	✧	❶	❶	✧	
Freshwater delivery to shorelines and estuaries supports estuarine, nearshore and marine food webs and the habitats upon which they depend	✧	✧	✧	✧	✧	❶	✧	
Flooding hazards do not harm people, residences, and transportation	✧	✧				❶	✧	
Loadings of toxics, nutrients, and pathogens do not exceed levels consistent with healthy ecosystem functions	✧	✧	❶	❶	❶		✧	
Toxics in marine waters and sediments, and in mammals, fish, birds, shellfish, and plants in these waters do not harm the persistence of these species	②	②	②		❶		②	
Pathogens, nutrients, and ocean influences do not harm the mammals, fish, birds, shellfish, and plants that depend on the marine waters of PS	②	②		②	❶		②	
Pathogens, nutrients, toxic contamination, sedimentation, elevated temperatures, and other water quality concerns do not harm fish, invertebrates, and wildlife that depend on the fresh waters of PS	②	②	②	②	❶		②	

<sup>2</sup> ❶ = outcome is a primary means of defining success for this objective; ② = outcome is directly relevant to achieving this objective; ✧ = indirect relationship b/w outcome & objective